

## Iron Age in India : A Reappraisal

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### Introduction

The British were bewildered with the Iron technology of India as what ordinary Indian village people and hill tribes carried on, the metallurgists and experts smiths could not do in England even in workshops and factories. Yule, Burnell, Peareson, Mushet, Stodart, Wilkinson, Heath and host of others wrote about Indian Iron and steel technology, furnaces and Indian methods of smelting, casting and other techniques since 18th century from the personal witnessing. The more they studied the more they realized the antiquity of Iron in India and its superior technology. The skill and craftsmanship of Indian metal workers had been so famous and in demand since c. 4000 BCE, their work recorded even upto 11th-14th centuries has been remarkable.

They were getting regular orders from all over the world for the manufacture of images, lamps, utensils, etc. However, it is a surprise to note that these details are not mentioned in Indian books. Therefore, a doubt arises as to whether the British and western scholars decided to suppress many facts of Indian science and technology. The history of Iron and Iron technology has perhaps been one of them (Yule's sketches to illustrate notes on the Kasia hills producing Iron are shown on RHS).

Readers of Indian history can understand as to how the historians have been changing their stands on Iron Age in India, however sticking to the hypotheses and theories of "Aryans" and "Dravidians" interpreting archaeological evidences differently. The doyen of Indian archaeology H.D. Sankalia had been indecisive about fixing of Iron age for India, as he moved to different dates- 1000 BCE, 800 BCE, 600 BCE, 400 BCE and so on. Though, Indian evidences of Iron have been *manufactured ones*, i.e., the ore was smelted, metal worked, and artifacts manufactured more than 3000 years back, such facts are not mentioned and discussed.

One can easily note the difference between *Iron in India* (presence or availability) and *Iron Age* (usage of it extensively) in India. However, the geologists proved that the presence of Iron-ore is

dated back to the Archaen system. It is interesting to note as to how the geologists also use "Aryan group/Aryan Era" and "Dravidian group/Dravidian Era" in the geological formations of India, just as Fergusson classified the Indian architecture/sculptural style. Therefore, it is imperative that the study should be free from such pseudo-scientific race hypotheses, emotional linguistic theories and professional ideological bias and prejudice.

### Iron in India — Earlier Hypotheses and Theories

First, the western scholars, about the introduction of Iron in India floated many hypotheses and theories. First, they floated the hypothesis that the Greeks introduced Iron technology in India; then, they attributed to Achaemenian comparing the similarities between the sculptures of Persepolis and Mauryans. When Megaliths posed problem, they started citing that the Hittites on 19th cent. BCE kept the secret of Iron making and after the collapse of their empire, it spread from them to other civilization after 1200 BCE. Then, they tried to link with "Aryan invasion" of India. Some of them are tabulated as follows as illustration :

Propounder	Hypothesis / Theory	Source/references
R.E. Mortimer Wheeler	Came to India with the Achaemenide empire in the 5th cent. BCE. He also suggested the Greco-Roman influence.	<i>Early India &amp; Pakistan</i> , London, 1959
D. H. Gordon	Suggesting the Greco-Roman influence, he places it between 450-400 BCE ( <i>Prehistoric Background of Indian Culture</i> , Bombay, 1958, p. 24). He also says at another place that iron was introduced in South India by people who cannot be other than Dravidian between 700 and 400 BCE.	<i>The Early Use of Metals in India and Pakistan</i> , Journal of Royal Anthropological London, lxxx, pp. 55ff.
R.F. Tylecote	Associated with the migration of Aryans to India around 1000 BCE to the Northern part of, where they stayed a while before moving to south India.	<i>The Met and Mat</i> , Technology July, 1984, p. 343.
Kamil Zwelebil	Proto-Dravidians migrated to India either before the Harappan civilization or together with its mature phase spreading to rest of India. Then Dravidians lived with Aryans. Then, they moved to East and South-east India and developed iron smelting in central India, Bihar etc.	<i>New Orient Prague</i> , 4, 3, 1965, p. 65.
Haimendorf	Dravidians arrived with iron and megalithism directly across the sea into south India about 500 BCE.	<i>Indo-Asian Culture</i> , Vol. 2, 1954, pp. 238-247.

contd...



<i>Propounder</i>	<i>Hypothesis / Theory</i>	<i>Source / references</i>
S. Rai, N. Rajan, M. Singh	With the fall of Hittites, the Iron technology migrated to India from Mediterranean megalithic culture (Mesopotamia).	Bulletin of Metro Museum, Vol. 10, 1985, p. 35.
N.A.V. Murthy	Technology of Iron making came to India from Afghanistan-Baluchistan region and transformed into local technology.	Archaeological Data on Metals in Ancient South India, Seminar on Metal Industries of South India, Thanjavur, 1983.
M.N. Banerjee	Invading Aryans introduced Iron in 1080 BCE.	Indian Historical Quarterly, 1929.
K.C. Varma	Vedic Aryans did not possess knowledge of Iron when they reached India and either originated it or borrowed it from some other people in India itself between 1900-1500 BCE.	<i>The Iron Age, The Veda and The Historical Urbanization</i> , p.167 (in <i>Indian Archaeology- Perspectives</i> ), New Delhi, 1972.

Thus, it is abundantly evident that the scholars have not studied the issue technically, instead, they have interpreted accepting the discarded racial theories. It is also interesting to note that Indian scholars followed them without going into or verifying the details given by them. It is strange that they had already accepted that Iron was introduced into India and proceeded their research. When new archaeological evidences started posing problems, the issue of Megaliths and Painted Grey Ware are linked.

### Iron Age and Megalithic Culture

The megalithic culture of India has been unique in India spreading all over the land, interestingly with Iron technology. Even in the case of origin of Megaliths, both western and Indian scholars have been consistent and different authors have opined variously, but mainly based on Aryan-Dravidian hypotheses and tabulated as follows:

<i>Author</i>	<i>Period Assigned</i>	<i>Place</i>	<i>Originated from</i>	<i>Reference</i>
Walter Reubens		Chota Nagpur	Western Origin reached Indian through Palestine and Russia.	
Elliot Smith	Between 5th-4th millennium BCE		From Egypt	

*contd...*

<i>Author</i>	<i>Period Assigned</i>	<i>Place</i>	<i>Originated from</i>	<i>Reference</i>
B.B Lal	700-500 BCE	South India	Nubia, though Nubia had no iron!	Indian Archaeology – A review, 1961-62, pp. 67-70., ILN, 1963, pp. 576-81.
M.H. Krishna	2000-200 BCE	Chandrahalli		
R.S. Panchamukhi	1200-1000 BCE			
G.S. Ghurye	1000 BCE		Though Megaliths were were connected with Egypt, dolmen was indigenous	Man in India, VI, 1926, pp. 26-27, 100-139.
P. Mitra	1000-300 BCE		Erythraean culture	
D.H. Gordon		Came across Arabia around 700-400 BCE.	From Mediterranean came as traders and colonists	
Von Christopher Haimendorf	500 BCE	700-400 BCE	Arrived with iron and megalithism across the sea	JASB, Vol. II, 1943.
B.K. Thapar	200 BCE – 100 CE			
B. Subbarao	600-500 BCE			
N.R. Banerjee	700 BCE – 200 CE			Iron Age in India, 1965, p. 264.
D.C. Sircar	500 BCE		Before Mauryas, Dravidians had Control over Mysore	
Gaur	2000 BCE	India itself	Satapata Brahmana	Problem of Megaliths, 1969, Varanasi

Thus, it may be noted that there have been three broad views about the origins :

1. The megaliths came from middle-east/Mediterranean region.
2. Came from Central Asia through north-east.
3. They were indigenous.

L.A. Krishna Iyer notes the view of Macdonell that Iron age in India might be taken prior to 2000 BCE and Gowland, a metallurgist that the South Indian iron industry was more ancient than European. The iron smelting at Gufkral in the Kashmir valley belonging to megalithic period had been dated to 1300 BCE and 2000 BCE, but the scholars had reservation about it. A. Sundara points out recently that Karnataka evidences are dated to c. 1440 BCE (Komaranahalli), c. 1380 BCE (Red ware pottery) and c. 1320 BCE (Black ware pottery). Therefore, when Macdonell opined the date of 2000 BCE, he must have known the lacunae in the climes of other civilizations in contrast to India. The Problem of Black and Red Ware has also been linked with Megaliths.

### Iron Age and Painted Grey Ware (PGW)

The discussion of date of Vedas, Aryans, introduction of Iron in India by aryaans etc., in the archaeological context has been mixed with the occurrence of Painted Grey ware (PGW) and started reducing the date to 1200 BCE from 8000 BCE / 6500 BCE / 3500 BCE etc. According to archaeologist, the following points have been supposed:

1. The PGW cultures may be credited with the introduction of iron in the Gangetic basin.
2. It is extended in north-west and north Indian parts.
3. From the total pottery produced, though only small percentage of painted grey ware one have been found, the culture has been designated as PGW.
4. It has been dated to 1000- 400 BCE.
5. The people who used PGW lived in mud houses without coinage or wrigings, i.e., they belong to pre-historic.
6. Iron and glass technology had been hallmark of such culture.

As the availability of PGW has been meager compared to other categories, the much fuss made about it is intriguing. The excavations at Bhagavanpura and other place revealed a pre-Iron phase of PGW. Archaeologists though insist that PGW should be associated with "Aryans" have not given reasons and do not explain this pre-Iron phase of PGW.

Site	Sample	C-14 date in BCE	Corrected Date in BCE	Culture Period
Loebanar (Swat valley) now in Pakistan	BM-195	1120-154	1400	Ghalighai
	BM-195	985-154	1100	
	R-474	510-72	490	
	Timargarh	1530-62	1870	
Pirak, Baluchistan		940-62	1035	Iron age
	TF-1108	775-105	870	
	TF-12101	775-155	870	
	TF-861	785-880		
	TF-1109	830-125	970	
Noh, Rajasthan	TF-1202	1075-80	1470	Unknown
	ULCA-703B	820-225	970	
	TF-993	725-150	885	
				P.G. ware
				Do



Site	Sample	C-14 date	Corrected Date in BCE	Culture Period in BCE
Sonepur, Bihar	TF—376	635-110	775	Black-Red Ware
Chirand, Bihar	TF—336	765-100	860	Do
Mashisdal, West Bengal	TF—389	690-105	800	Do
Hallur, Mysore	TF—573	955-100	1065	Neolithic— Megalithic
	TF—570	1105-105	1410	Transition
Atranjikhhera, Etah Dt., UP	TF—191	1025-110	1285	Iron Age
	ULCA—703B	821-220	970	
Ahar, Tambavati, Rajasthan	TF—31	1270-110	1570	
	TF—32	1550-110	1900	
Eran, Saugar DT, MP	TF—326	1049-110	1320	Iron objects: Layer 16
	TF—324	1175-105	1470	Layer 14

Table taken from K.C. Varma, pp. 157-158.

The table clearly shows that there is no condition that Megaliths, Iron and PGW should go together. Even, Neolithic and megalithic can overlap, which is interpreted as transition. No racial attribution could be made to PGW or Black-Red Ware, as they appear during Iron and pre-Iron or non-Iron culture (Cooper/Bronze). Therefore, the attribution of PGW to "Aryans" and Black-Red Ware to "Dravidians" appear to be motivated for other reasons other than archaeological principles.

### Copper versus Iron Ages

About the Copper and Iron Ages too, the scholars have not been conclusive, but floated different hypotheses and theories in Indian context. When Copper Age could go back to c. 3500 BCE, why not Iron is also not explained.

The Western View of Iron Age is as follows:

1. Iron Age of period is the usage and development in a culture continuing into modern times.
2. The western scholars assert that in Asia, Egypt, and Europe it was preceded by the Bronze Age and it did not begin in the Americas until the coming of the Europeans.
3. Though, Iron beads were worn in Egypt as early as 4000 BCE, they were of meteoric iron, evidently shaped by the rubbing process used in shaping implements of stone. The oldest known article of iron shaped by hammering is a dagger found in Egypt that was made before 1350 BCE, but attributed to Hittite workmanship.
4. The use of smelted iron ornaments and ceremonial weapons became common during the period extending from 1900 to 1400 BCE coinciding with the invention of tempering was made by the Chalybes of the Hittite empire.

5. The Hittite kings kept iron working techniques secret and restricted export of iron weapons. After the downfall of the Hittite empire in 1200 BCE, the great waves of migrants spreading through Southern Europe and the Middle East insured the rapid transmission of iron technology.

6. In Europe Knowledge of iron smelting was acquired in Greece and the Balkans, and somewhat later in Northern Italy and central Europe. The Early Iron Age in central Europe, dating from c. 800 BCE to c. 500 BCE, is known as the *Hallstatt* period.

7. Celtic migrations, beginning in the 5th cent. BCE, spread the use of iron into Western Europe and to the British Isles. The Late Iron Age in Europe, which is dated from this period, is called *La Tene*.

8. The casting of iron did not become technically useful until the Industrial Revolution.

9. The people of the Iron Age developed the basic economic innovations of the Bronze Age and laid the foundations for feudal organization. They utilized the crops and domesticated animals introduced earlier from the Middle East. Ox-drawn plows and wheeled vehicles acquired a new importance and changed the agricultural patterns. For the first time humans were able to exploit efficiently the temperated forests. Villages were fortified, warfare was conducted on horseback and in horse-drawn chariots, and alphabetic writing based on the Phoenician script became widespread.

10. Distinctive art styles in metal, pottery, and stone characterized many Iron Age cultures.

These are the features of Copper/Bronze Age:

1. Bronze Age or period is the usage and development of technology when metals were first used regularly in the manufacture of tools and weapons for which pure copper and bronze, an alloy of copper and tin, were used.

2. The earliest use of cast metal can be deduced from clay models of weapons. Thus, they assert that *casting* was certainly established in the Middle East by 3500 BCE.

3. Following the *Neolithic period*, the development of a metallurgical industry coincided with the rise of urbanization because the organized operations of mining, smelting, and casting undoubtedly required the specialization of labor and the production of surplus food to support a class of artisans, while the search for raw materials stimulated the exploration and colonization of new territories.

4. This process culminated in the civilizations of *Mesopotamia* and *Sumer*. Later, the *Minoan civilization* and the *Mycenaean civilization* opened extensive trade routes in central Europe, where tin and copper were mined. This activity fostered native industries and political unification, especially in Hungary, Austria, and the Alpine region.

5. It laid the foundations of the *Iron Age* civilization, which was to follow under Greek, Etruscan, and Scythian influences. In the New World the Earliest bronze was cast in Bolivia c. CE 1100.

6. The *Inca* civilization used bronze tools and weapons but never mastered iron.

Here, it may be noted that they have purposely silent about India and Indian Copper and



Iron Ages. Moreover, here are the currently understood divisions of Prehistory have been applied as follows:

- (i) The Paleolithic Era (Lower, Middle & Upper)
- (ii) The Mesolithic Age
- (iii) The Neolithic Age
- (v) The Bronze Age
- (v) The Iron Age

Why and how these ages follow exactly the pattern at all times in all circumstances? why and how people of different civilizations should pass through the same ages precisely like this? Thus, so many assumptions and presumptions have been incorporated in such classification of ages and periods. Moreover, the archaeologists themselves know very well that such a periodization is not applicable to every ancient civilization. The people of any civilization need not have progressed or developed exactly with the same scale.

#### Meteorite and Smelted Iron Evidence

The much publicized Egyptian and Mesopotamian Iron artifacts dated to c. 4000–3500 BCE had been proved to be made of meteorite conglomeration containing 7.5% (Egypt) and 10.9% (Ur) Nickel in them and not man made Iron i.e., not smelted. But, the Indian evidences dated to c. 1500 BCE have been smelted and manufactured out of such Iron. The only hammered dagger found at the Egyptian tomb had also been manufactured by Hittite and dated to c. 1200 BCE. However, these scholars do not reveal how the Hittite got the technology.

The Hittite documents, interestingly mention that the person who commanded or ordered to manufacture Iron articles is described as “the man of *Puruskhanda*”, definitely, it is neither Egyptian nor Babylonian but sounds Indian. Scholars have already pointed out the close relation between the Indians and Hittites. In a treaty between the Hittites and the Mitanni, Indic deities Mitra, Varuna, Indra, and Nasatya (Ashvins) are invoked. A text by a Mitannian named Kikkuli uses words such as *aika* (*eka*, one) *tera* (*tri*, three), *panza* (*pancha*, five), *satta* (*Sapta*, seven), *na* (*nava*, nine), *vartana* (*vartana*, round). Another text has *babru* (*babru*, brown), *parita* (*Palita*, Grey), and *pinkara* (*pingala*, red). Their chief festival was the celebration of *vishuva* (solstice) very much like in India. It is not only the kings who had Sanskrit names; a large number of other Sanskrit names have been unearthed in the records from the area. A Hittite figure is shown on LHS.

Therefore, Hittites must have obtained the knowledge of Iron technology from India. According to Indian documents, they are the degraded Kshatriyas/warrior class group excommunicated from India. Then, their knowledge of Iron is explicable, and there is no or 1200 BCE coincided with the Iron age of India as has been accepted by the modern scholars. There Egyptians claimed that they came from an holy land situated in the east. Their fascination to have trade with Punt is very interesting and it is located in India. Though, it is uncertain what modern geographic territory corresponds to this “Land of Punt,” historians located in eastern Africa, possibly near what is now *Somalia* or *Eritrea*. However, on the southern coasts of the *Arabian Peninsula*, *Mozambique* and *India*. H.R. Hall specifically identifies it with a part of India. In any



case, the Indian connection is significant. That the Greeks, Roman, Persians and others imported Iron sheets and articles have been accepted by their documents themselves.

The Egyptian word "*bia*" connotes Iron, but has other meanings— heaven, meteorite, coarse grained red quartzite and bone. That they considered Iron as bone is vouchsafed by Plutarch, who recorded that Egyptians called iron "bone of Typhon/Seth." This is nothing but the thunder bolt/ weapon/ *vajra ayudha* of Rain God known as Indra. They say, "..... *bia* which came forth out of Setesh (seth, the storm-god)" also, "*bia-ni-pet*", the metal of sky. According to the Boghazkoy (the capital of Hittites) inscription, Hittites knew that Iron was black, black iron of heaven from the sky, the gold they bring from the city of *Bi* ....., the silver from *Kuzza*, black iron of heaven from the sky, copper and bronze from the city of *Alasiya* and Mount *Taggata* (translation of Saye of Boghazkoy inscription in Man, 1921, No. 97). Had the Hittites been different from Indians or not related to them, their source of iron would have been revealed, instead of mentioning that it had come from the sky like the Egyptians. Therefore, in all probabilities, it is evident that the Iron technology had developed around 2000 BCE in India and spread westwards to the other ancient civilizations.

### Iron Age according to Indian Documents

As for as India is concerned, it is well known fact, even known to common man, that the present age is Iron Age i.e., Kali yuga, the dark age. According to Indian cosmology and astronomical treatises, the Four Ages— Treta, Krita, Dwarapa and Kali have been attributed to four metals— Gold, Silver, Copper and Iron. Interestingly such classification of periodization has been there in the traditions of the Hebrews, Greeks and others. Therefore, there is a reason to believe that the same order has been consciously followed by the archaeologists without any reasoning according to their field-expertise.

Only the Indian scriptures (particularly *Kaliyugavryahyas* = the prohibitions of Kaliyuga) prohibit the usage of Iron and consider it inauspicious. It is a common practice that none would accept Iron free of cost and even stealing Iron is considered as a great sin as it would bring downfall or bring pauperism to one. On the other hand, the Copper/Bronze vessels, utensils and artifacts are sanctified and encouraged for use. Incidentally, the Iron vessels or utensils harm the food or drinks stored in them, whereas, the Copper/Bronze ones do not affect. Such sanctification of Copper/Bronze and prohibition of Iron might have increased the export of Iron and Iron articles, as has been duly acknowledged by the Greeks, Romans, Persians and others.

In contrast, Egyptians, Assyrians and others considered Iron as divine, heavenly, gold coming from heaven and so on. As they did not have such technology, they imported from India. Before the collapse of IVC, perhaps, Hittites sold the Iron implements obtained from India to Egypt (just the Arab traders did later).

### How the Iron Age is interpreted?

The study of Iron by the scientists and historians differ considerably. Historians interpret the data and information on Iron available to them, whereas, scientists go into the physical and chemical parameters of the element and connected environmental processes affecting it. While historians, archaeologists and other interpreted as above, of later based on technical analysis of samples and other details, the following facts are brought out:

1. Iron-ore was there in India taking the evidences of Singhbhum, Bastar, Keonjhar, Bonai and Mayurbhanj (these belong to Dharwar and Cuddapah systems). Karnataka, Goa and Tamilnadu are upper Dharwar or Newer age ascribed to post-Cuddapah metasomatic action, to original marine and chemical precipitation of the oxides, carbonates and other compounds of iron, to volcanic action and other agencies. This is dated to millions of YBP.

2. Based on megalithic evidences, archaeologists interpreted that Iron must have been introduced into India c. 1000 BCE.

3. The Iron Age in India is classified as follows:

- \* The Early Iron Age (Second half of 2nd mill. BCE – 7/600 BCE):
- \* The main culture of this stage are:
- \* The Painted Grey Ware Culture
- \* The Black-and-Red Ware bearing Cultures (of Mid and Lower Ganga Plain)
- \* The Megalithic Culture (of South India).

The chronological framework and the utilization pattern with an impact on culture will be evaluated at the above stages.

- \* The Middle Iron Age (7/600–100 BCE)
- \* The Northern Black Polished Ware Culture – The emergence of cities vis-a-vis iron.
- \* The Late Iron Age (100 BC/CE–5/600 CE) — Culmination of technology and the golden age of iron technology in the Indian History.

4. Metallurgy of Iron in ancient India was studied by National Research Laboratory for Conservation of Cultural Property using chemical and metallographic analysis of a large number of excavated objects from the following sites belonging to different periods of Indian history:

<i>Sl. No.</i>	<i>Where Iron articles occurred</i>	<i>Dated to</i>
1.	Dwarka, Gujarat	1500-1200 BCE
2.	Tadakanhalli and Komaranhalli, Karnataka	1200-1000 BCE
3.	Khapa, Tkalghat, Mahurjhari, Arni, Central India	700-400 BCE
4.	Allahpur, Uttar Pradesh	400-300 BCE
5.	Soron, Uttar Pradesh	600 BCE– 1000 CE
6.	Attranjikhara, Uttarpradesh	600 BCE– 500 CE
7.	Jajmau, Uttar Pradesh	600 BCE – 500CE
8.	Hulaskhera, Uttar Pradesh	400 BCE – 500 CE
9.	Sringverpura, Uttar Pradesh	250 BCE– 600 CE
10.	Kausambi, Uttar Pradesh	800 BCE – 500 CE
11.	Khairadih, Uttar Pradesh	100-400 CE
12.	Manjhi, Bihar	600-500 CE



Chemical analysis of the samples showed that all the objects contained silica, alumina, lime and manganese as impurities in the iron, whereas antiquities from some of the sites were characterised by the presence of traces of chromium, titanium, nickel or phosphorous. The presence of silica, calcium and manganese in very low amount indicates that the metal used in these artefacts was extracted from ores and no meteoric iron was used.

Metallographic studies were carried out to obtain information on :

1. Mode and degree of carburisation of iron to make steel.
2. Technique of fabrication of the objects.
3. Heat treatment given to the objects to improve properties of the steel.

From the result of the studies on the artefacts from all the seventeen (17) sites and after reviewing the work done by earlier archaeo-metallurgist from all over India, the following conclusions can be drawn:

- \* Use of iron began around 1500-1200 BCE in the western region (Gujarat).
- \* Lamination technology (layering technique) using wrought iron and high carbon steel sheets alternately to fabricate weapons and tools, was developed in South India in around 1200-1000 BCE. The technology reached the hands of smiths of Central India by 700-400 BCE and that of Uttar Pradesh by 600 BCE.
- \* Case Carburisation technique was developed in around 600 BCE in Central India (Maharashtra) and Eastern Uttar Pradesh almost simultaneously.
- \* Heat treatment of medium and high carbon steel tools was developed by 600 BCE-300 CE in Eastern Uttar Pradesh and Central India (Maharashtra).

Thus, it is evident that the issue is wholly technical involving geological and chemical analysis in studying the samples to arrive at date of Iron. Hence from the view of historians, it is clear that they have not studied it critically, but, they simply interpret with the ready made data available to them without knowing or understanding the technical details involved in interpreting such details. That is why they are not consistent with the interpretation of the ancient period.

### **The Antiquity of Export of Iron articles from India**

The export of Indian goods to the ancient civilizations dating back to c. 4500 BCE has been well-recorded one. However, it is surprising to note that the historians have not studied or elaborated the role of India in such references. Though, the presence of Iron is traced to Ur and Egypt, they were not smelted ones, the western scholars surprisingly trace to meteorite origin! When worked ones were discovered, they attributed to Hittite origin, as they only first knew the Iron technology and manufactured and supplied iron articles to Egyptian and other civilizations c. 1350-1200 BCE.

1. The Romans and Greeks recorded in their texts that metals like iron, tin, copper and brass were imported from India, that too, in the form of sheets.
2. Modern metallurgists know how the Iron ore is converted into sheets and the technology behind it. The processes involved are – Smelting of Iron ore, alloying to make it strong, pouring

as pillets, rolling, and sheet forming. Therefore, it is evident that Indians had such technology of Steel making well developed before c. 500 BCE.

3. The Woots (later known as Damascas Steel) steel was produced extensively in South India and exported to Mediterranean countries c. 500 BCE.

4. During the reigns of the Roman Emperors Marcus Aurelius and Comodus, *Ferrum Indium* appears in the list of dutiable articles.

5. The Greeks tried to learn the Indian technology and compiled a chemical treatise entitled "*On the Tempering of Indian Steel*", Evidently from Indian books.

6. Edrisi has noted that "The Hindus excel in the manufacture of iron. They have also workshops wherein are forged the most famous sabers in the world. It is impossible to find anything to surpass the edge that you get from Indian Steel." This passage which has been quoted in the notes to the *Perplus* proves beyond doubt, in the words of a foreign historian, that the art of smelting and casting iron was well developed on ancient India.

7. Ktesias, a Greek writer who lived in Persia in the 4th century B.C. records the smelting of metals undertaken in India. He has written that, "Every year a spring filled itself with fluid gold which was drawn from it in one hundred earthen pitchers. It was necessary that they should be of clay, because the gold afterwards congealed, and the pitchers had to be broken in order to get it out." "Each pitcher contained one talent of gold." McCrindle, translating Ktesias, has noted that "The sense of this passage can only be that auriferous ores were melted, and that the gold obtained from them was drawn out in a fluid state. That there was a spring, must be a misapprehension, and we must imagine instead that there was a cistern prepared to receive gold." ... "If this supposition is right, it follows that the Indians knew how to extract gold from the ore by melting."

8. S.W. Schoff recorded about the export of Indian Steel to Abyssinia.

We shall now look into some of the metal that were being exported from India.

Metal Articles exported	The Greek, Roman sources Mentioning it	Inference / explanation
Iron and Iron articles	Marco Polo has mentioned that iron and Ondanque was sold in the markets of Kerman in Iran. The word <i>Ondanique</i> has been interpreted as a corruption of the Persian word <i>Hundwaniy</i> that meant 'Indian Steel.'	That India had been the major exporter of Ferrous and Ferrous alloy articles
Tin	Tin known as <i>Kassiteros</i> in the Greek language language was derived from the early Sanskrit word <i>Kasthira</i> . Evens today in some Indian language tin and aluminium are called <i>Kathila</i> , derived from Sanskrit word <i>Kasthira</i> .	The Greek historians recorded that Indians knew the value of tin for hardening copper and the art of hardening and tempering tin with other metals.

contd...



<i>Metal</i>	<i>The Greek, Roman sources</i>	<i>Inference / explanation</i>
<i>Articles</i> <i>exported</i>	<i>Mentioning it</i>	
Copper	The Periplus notes that Copper was imported as an article and copper ore was extracted in a big way smelted locally in South India and Rajputana. Philostratus of Lemnos, in about 230 CE noted that there was a shrine in Taxila in India, in which were hung pictures on copper tablets representing the feats of Alexander and Porus.	In the words of Philostratus "The various figures were portrayed in a mosaic of orichalcum, silver, gold, and oxidised copper, but the weapons in iron. The metals were so ingeniously worked into one another that the pictures which they formed were comparable to the production of the most famous Greek artists."
Brass	Brass is an alloy of copper and zinc. Philostratus noted that Indians knew the joining of metals while he was referring to Copper used for ornamental purposes. Therefore, it implies that alloying of Copper with Zinc resulting in Brass.	The "Joining of Metals" is interesting, as it would cover the processes of fusing, soldering, welding, brazing etc.
Corundum	<i>Curundum</i> implies crystallised aluminium oxide of various colours having great hardness and used as gems and also as an abrasive. Known as <i>Kuruvinda</i> in Sanskrit was one such gem exported.	The Oxford Dictionary records that the word Corundum is derived from the Sanskrit word <i>Kuruvinda</i> .
Noe-shadder	Might be Ammonium chloride also derived from Sanskrit root 'Narasara.'	Obtaining Chlorides of Ammonia implies the chemical technology behind it.
Beryl	Precious stone varying from pale green to yellow in colour exported from India.	The word Beryl is said to have been derived from the Sanskrit term <i>Vaidurya</i> .
Copal	It is an amorphous quartz like form of hydrated silica, some types of opal are semi-translucent and appear like glass.	The English Word Opal has been derived from the Sanskrit term <i>Upala</i> a fact which is corroborated by the Oxford Dictionary

### Iron in Indus Valley Civilization

As Indus Valley Civilization (hereinafter mentioned as IVC) was discovered only in 1920 and excavations started in 1920-21, and continued upto 1930-32, and the evidences point to higher date, they did not discuss and publish papers immediately. Moreover, the British controlled the excavation and reports. Even about the usage of metals, articles are not appearing in India, but

appearing in Western countries. To cite an example, though Marshall, Mackay and others found ferrous ashes in several layers, they refused to accept the presence of Iron in the IVC.

The ochre-coated pottery of IVC dated to c. 2600 BCE are predominantly displayed on exhibitions and websites, but though the ochre was made of Ferrous oxide, the presence of Iron is not stressed upon. Some of the ochre coated pottery (OCP) are shown on RHS.

Red oxide or Iron oxide was the source for the red colour and a combination of dark red-brown iron oxide and black manganese for black colour with which the pottery was painted, and these paints were manufactured by Indians and applied to the pottery artistically. When the western scholars publicized much about the meteorite artifacts, why not acknowledge usage of iron in c. 2600 BCE?

There has been another interesting item known as "snaling iron" or "bun type ingots," and their figures taken from "Antiquity" are shown below:

The so-called Harappan "snarling Iron" found at Chanhu-daro (8/B, 8/C and 9/C of mound II dated to second occupation of the settlement— mid 3rd to early 2nd millennium BCE) was snarled at Even in 1988, when Paul Yule writes about it he says,

*"While a chemical analysis of the metal is not available, arsenical and tin bronze was available in the Harappan period. The metal would be more suited to the task than copper. In any case our 'iron' is non-ferrous."*

Thus, he could decide even without chemical analysis, and assert that "their iron" is non ferrous.

The "Snarling Iron" is nothing but anvil on which smith hammers metal object/article under work hot condition. Some examples are shown on the RHS. Did the Indians keep the anvils just for fun working only non-ferrous artifacts, when iron oxide was applied to their pottery?

In fact, it was found in the quarters of metal workers. Meera Mukharjee showed that the descendants of snarling iron are still using the same technology in India. Therefore, Indian historiography should take these factors into account to write Indian history. Here, a historian cannot write history without knowing ferrous/non-ferrous metals, metallurgy and the techniques involved.

### **Indigenous Development of Iron Technology**

Madhav Gadgil and N.V. Joshi have given interesting maps of the spread of Iron technology in the ancient India in "PEOPLE OF INDIA" in the website <http://ces.iisc.ernet.in/hpg/cesmg/peopling.html#sec9>. The map is reproduced below for discussion.



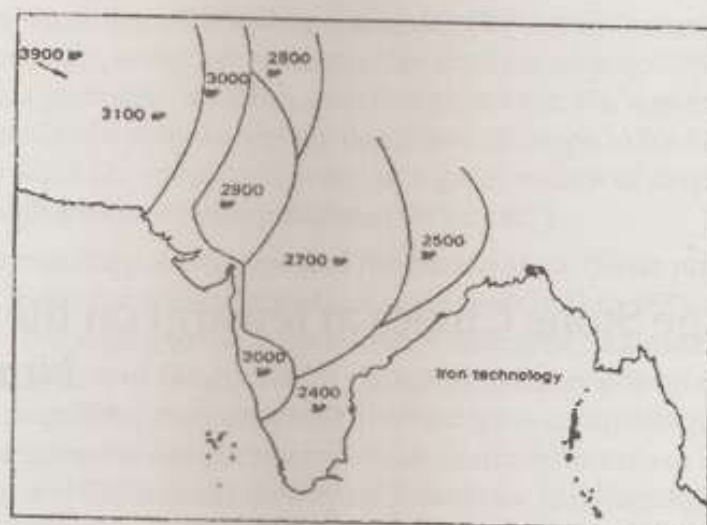


Fig. 1. The earliest known dates of appearance of iron technology in different parts of India